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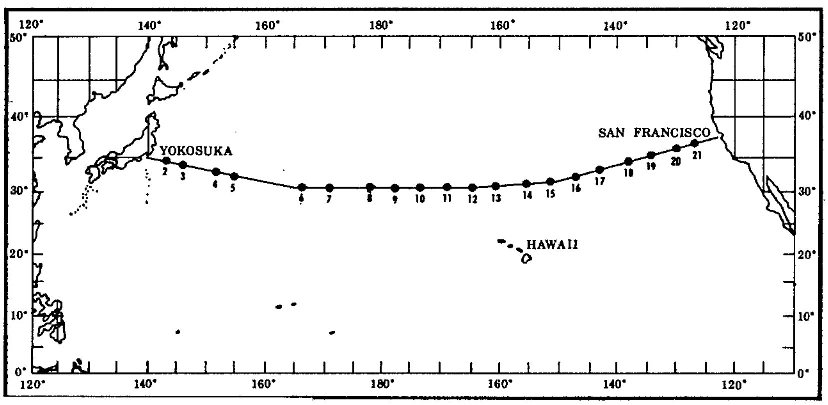
IR No. 70-26

INFORMAL REPORT

OCEANOGRAPHIC CRUISE SUMMARY MID-LATITUDE TRANSIT OF THE NORTH PACIFIC OCEAN BY THE USNS CHARLES H. DAVIS (T-AGOR 5) OCTOBER 1969



APRIL 1970

NAVAL OCEANOGRAPHIC OFFICE
WASHINGTON, D. C. 20390

INFORMAL REPORT

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ABSTRACT

This informal report contains a summary of oceanographic data obtained during the October 1969 transit of the Pacific Ocean by the USNS CHARLES H. DAVIS (T-AGOR 5). Sound velocity and oxygen sections are presented for the transit. A comparison of the sound velocity section with one taken along the same track by the USS REHOBOTH (AGS 50) in March 1968 shows remarkable similarity except near the surface where the March 1968 section shows better mixing. A new oxygen sensor, the Beckman Instruments, Inc. Minos dissolved oxygen monitor, was used to measure oxygen content. Comparisons were made between the oxygen sensor and Microwinkler oxygen methods from data obtained on the USNS LYNCH (T-AGOR 7) in January 1970. Of 211 water samples taken at seven stations, 91% of the data points agreed within $\pm$ 0.3 ml/L, 81% agreed within $\pm$ 0.2 ml/L, and 68% agreed within $\pm$ 0.1 ml/L.

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RESEARCH SHIPS BRANCH
DEVELOPMENTAL SURVEYS DIVISION
OCEANOGRAPHIC SURVEYS DEPARTMENT

This report has been reviewed and is approved for release as an UNCLASSIFIED Informal Report.

B. C. Byrnes

B. C. BYRNES
Director
Developmental Surveys Division

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FIGURES

FIGURES (cont.)

OBJECTIVES

The primary objective of this cruise was to retrace the March 1968 route of the USS REHOBOTH (AGS 50) and to repeat sound velocity measurements made during that cruise in order to determine seasonal effects on the sound velocity structure. Secondary objectives included the underway measurement of bathymetry and total magnetic intensity and the dropping of expendable bathythermographs at six hour intervals. SUS charges were to be launched periodically and navigation was to be accomplished with a satellite navigation system. Other opportunity data such as the recording of deep scattering layer and biological sampling were to be collected as time and facilities permitted. The cruise was also expected to yield data on the performance of a new oxygen sensor on lease from Beckman Instruments, Inc.

NARRATIVE

The USNS CHARLES H. DAVIS (T-AGOR 5) departed Yokosuka, Japan on 1 October 1969. The following personnel made up the scientific party: Oceanographers, Ouick Carlson, T. D. Edsall, W. R. Heiner, Kent Hughes; Engineer, Michael Rivers; and Physical Science Aid, Melvin Nelson. The Coordinator was W. W. Van Atta and Rudy Nieto was the Electronic Technician.

The ship's track is shown in Figure 1. The stations are approximately 24 hours apart. Positions of these stations do not correspond to the positions on the REHOBOTH 1968 crossing but they are along the same track. Figure 2 shows in summary form the measurements made during the transit. Sound Velocity-Oxygen-Pressure (SVOP) casts were

made at all stations. Data from Station 1 was not usable because of instrument problems so acceptable stations are numbered 2 through 21. Nansen casts were taken at Stations 2, 6, 9, 14, and 21. Considerable difficulty was experienced with the Nansen bottles and reversing thermometers during the first half of the cruise and because of the pressing ship schedule no attempt was made to repeat casts. All Nansen casts were made on the electrical cable used for the sound velocity and oxygen measurements and at the same time. The cable was a modified type 4HO oceanographic cable with added insulation around each of its four conductors, resulting in an outside diameter of 0.22 inches instead of 0.185 for the conventional 4HO cable.

No station was occupied on 6 October 1969 because of the heavy seas resulting from Typhoon GRACE. No station was taken on 10 October because the ship was lagging behind her schedule. This schedule was subsequently modified and daily stations were resumed for the remainder of the cruise.

XBTs were taken four times daily at 0000Z, 0600Z, 1200Z and 1800Z; mixed layer temperature and mixed layer depth are shown in Figure 2 along with generalized magnetic intensities and bathymetry.

Sound velocity measurements were made with a Mark I Deep Sea Probe manufactured by Ramsay Engineering Company. This probe used a 10,000 psi Vibrotron pressure sensor. The total accuracy of the digital sound velocity data is within $\pm$ 1 meter per second and the sensor depth accuracy is estimated to be within $\pm$ 5 meters near the surface and $\pm$ 50 meters at 2000 meters depth. These estimates combine all errors including calibrated repeatability, winch speeds, readout instrument error, thermal effects, mechanical hysteresis, and ship's motions.

Dissolved oxygen was measured by a sensor developed by Beckman Instrument, Inc. The oxygen sensor was mounted on the sound velocity probe and a bridle was constructed to allow the sensor package to be lowered in a horizontal position. Figure 3 shows the instrument being lowered.

Each day the sensor package was lowered until 2000 meters of cable were out. Winch speeds were 60 meters per minute for the first 100 meters, and then 120 meters per minute to the maximum depth. The return speed was 120 meters per minute all the way. These speeds varied on casts which included the attachment of Nansen bottles to the electrical cable.

SHIPBOARD PROCESSING

Frequency modulated signals from the sound velocity, oxygen and pressure sensors were first filtered and separated, fed into individual counters, and recorded on a paper tape punch of the AGODDS (AGOR OCEANOGRAPHIC DIGITAL DATA SYSTEM) which is described in Carlson and Merrifield, 1966 . The cast was also recorded on a two pen XYY Recorder. A block diagram of the AGODDS is shown in Figure 4.

SOUND VELOCITY DATA

Figure 5 shows the sound velocity section across the Pacific in October 1969. Figure 6 shows a section along the same track made in March 1968 by the REHOBOTH. The velocity structure in these two seasons of the year are remarkably similar. The minimum velocity axis ranges from 900 to 1000 meters off Japan to 600 meters off San Francisco, California.

The only significant difference between the two sections is in the surface layer which appears to be well mixed to 200 meters in March, but stratified in October, showing the effects of the prevailing weather in the two seasons.

DISSOLVED OXYGEN DATA

Figure 7 shows the dissolved oxygen concentrations across the Pacific in October 1969. These data were plotted from the digital recordings.

The Beckman "Minos" Dissolved Oxygen Monitor is an improvement, representing several orders of magnitude, in time and manpower over the classical method using Nansen bottles and manual titration of each sample. It has been claimed (Beckman, 1969) that the duplication of the six-meter resolution of this sensor would require about 333 water samples in a cast to 2000 meters. The ability to process digital data in real time reduces the time required for collecting and processing this number of samples from a matter of days to less than one hour.

The accuracy of this device relative to classical methods has been under study on subsequent cruises. Comparative measurements were conducted aboard USNS LYNCH (T-AGOR 7) in the Caribbean in January and February of 1970 using the Microwinkler method described in H. O. Pub. 607. It was not possible to run duplicate titrations, however, because of the need for water samples for other analyses.

Figure 8 shows that the accuracy of the oxygen sensor when compared to this modified Microwinkler method is generally within $\pm$ 0.3 ml/L or 3% of full scale of the instrument. Much of the scatter shown may be the result of the time elapsed between the collection of the water sample by the Nansen bottle and the recording of the value at the same depth by the oxygen sensor which

in some cases amounted to several hours. This is especially true near the surface where conditions are expected to be more changeable. Most of the scatter, however, is clearly within the Microwinkler data itself. Evidence for this is displayed in the instances where an upper and lower Nansen cast overlapped. These samples were collected at the same depth but at different times and are shown in Figure 8 connected by a line.

Nearly all of the 33 analyzed profiles made during three cruises to-date displayed distinct vertical variations in oxygen on the down-cast that faithfully reproduced themselves on the upcast. Other continuous measurements made simultaneously with the same sensor package included temperature on one cast and sound velocity on 20 casts. Typical profiles are shown in Figures 9 and 10. In most of these casts there did not appear to be strong variations in sound velocity or temperature at the same depths as variations in oxygen.

It appears that these oxygen variations are not strongly related to temperature and sound velocity but are probably the result of biological activity. During one cast a deep scattering layer was encountered. Figure 11 is a photograph of the 12 KHz echo sounder record showing the deep scattering layer and the probe descending through it. Figure 12 shows the corresponding oxygen profile. One might expect to see a depletion (or abundance) of oxygen in the region of the deep scattering layer owing to the biological nature of that phenomenon. No correlation is apparent, however, between oxygen concentration and the deep scattering layer. This lack of correlation might indicate that the populations consuming oxygen are not good reflectors of 12 KHz signals. It seems more likely, however, that the ambient oxygen levels are the result of population

distributions extending over long periods of time and are the residual effects of many cycles of migration.

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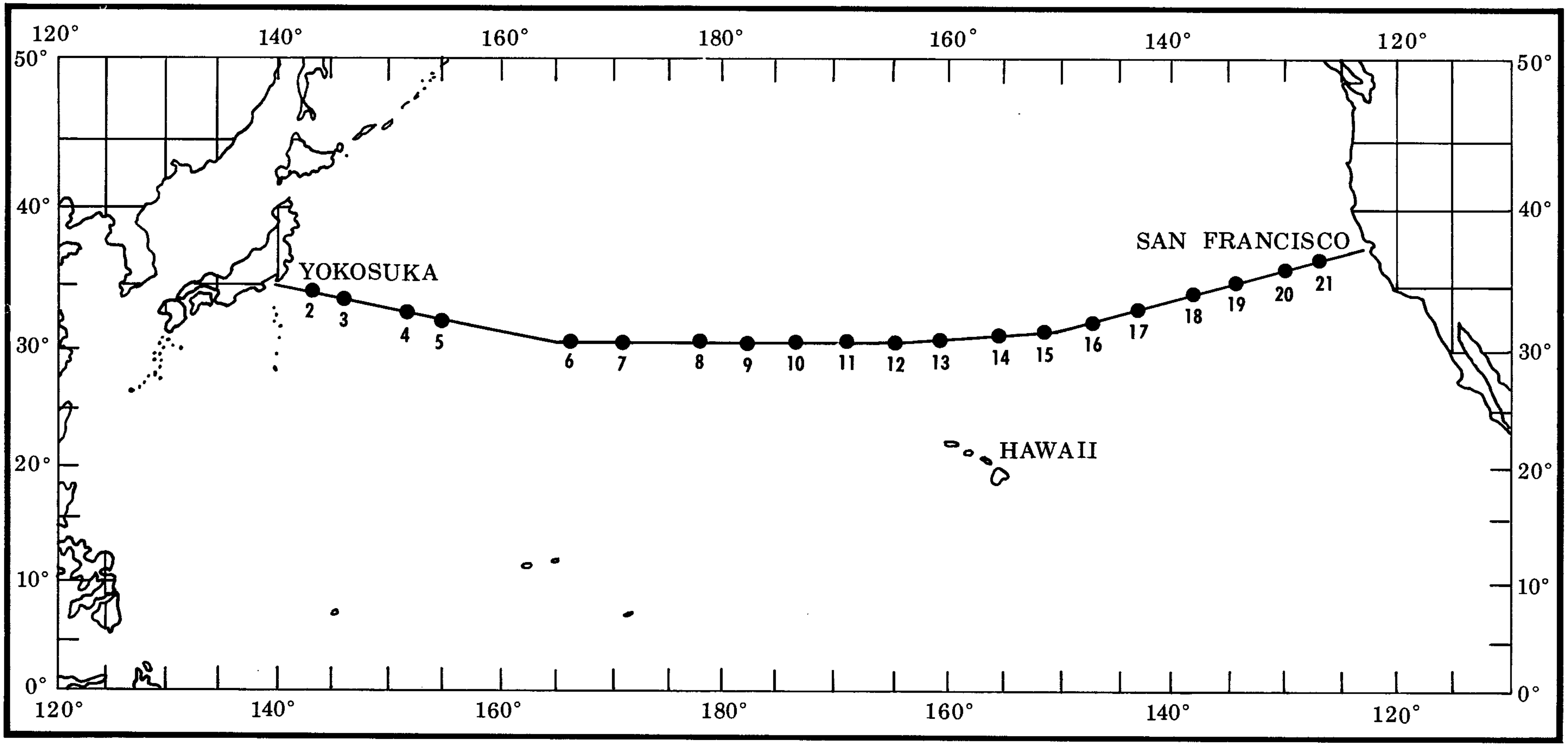

FIGURE 1. SHIP'S TRACK AND STATION LOCATIONS OF USNS DAVIS, 1—24 OCTOBER 1969.

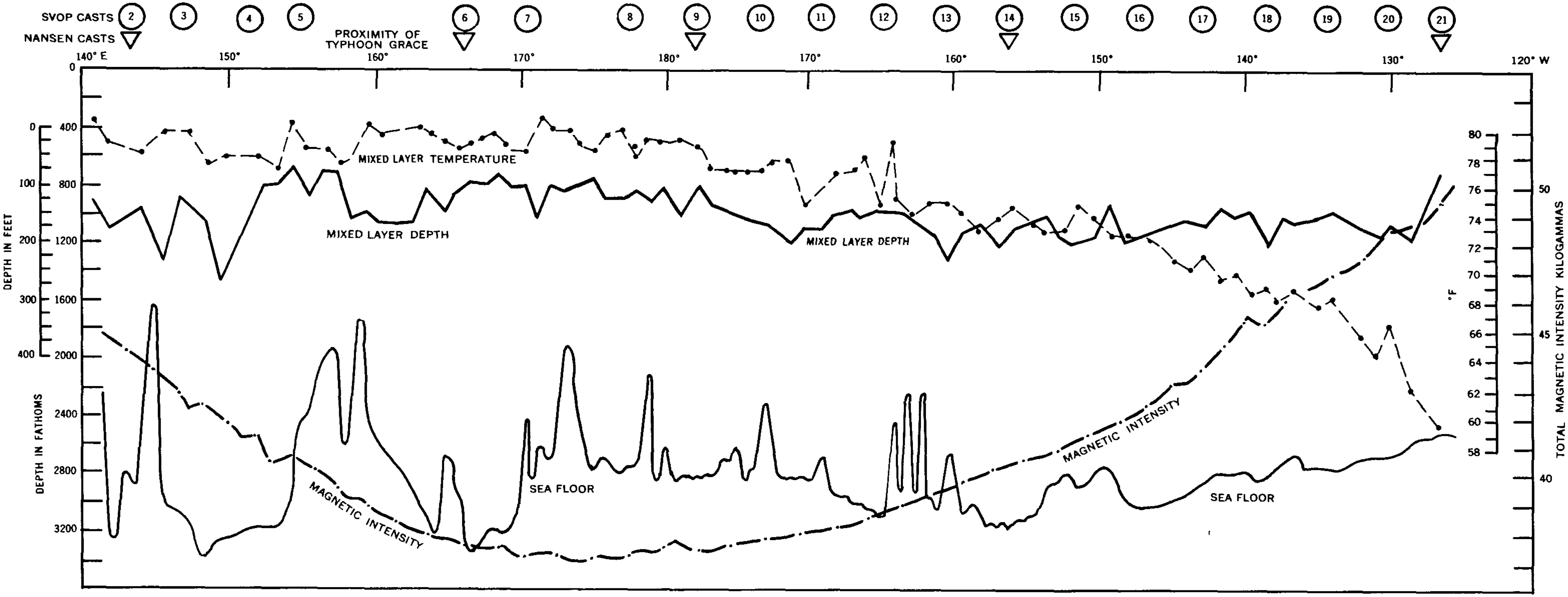

FIGURE 2. SUMMARY OF MEASUREMENTS.

FIGURE 3. LOWERING SOUND VELOCITY, OXYGEN, PRESSURE (SVOP) SENSOR. (THE BECKMAN DISSOLVED OXYGEN MONITOR IS MOUNTED BELOW A RAMSAY MK 1 DEEP SEA PROBE.)

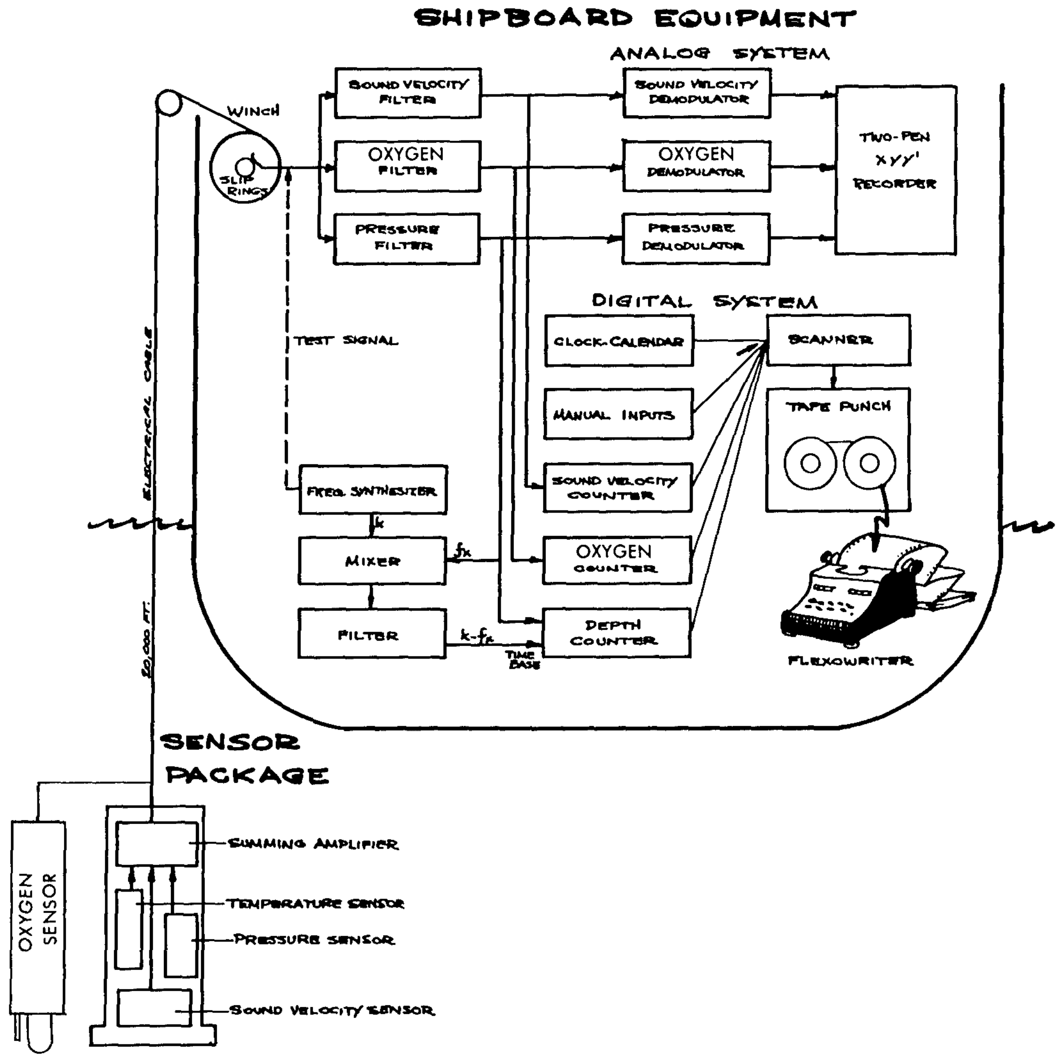

FIGURE 4. AGOR OCEANOGRAPHIC DIGITAL DATA SYSTEM (AGODDS)

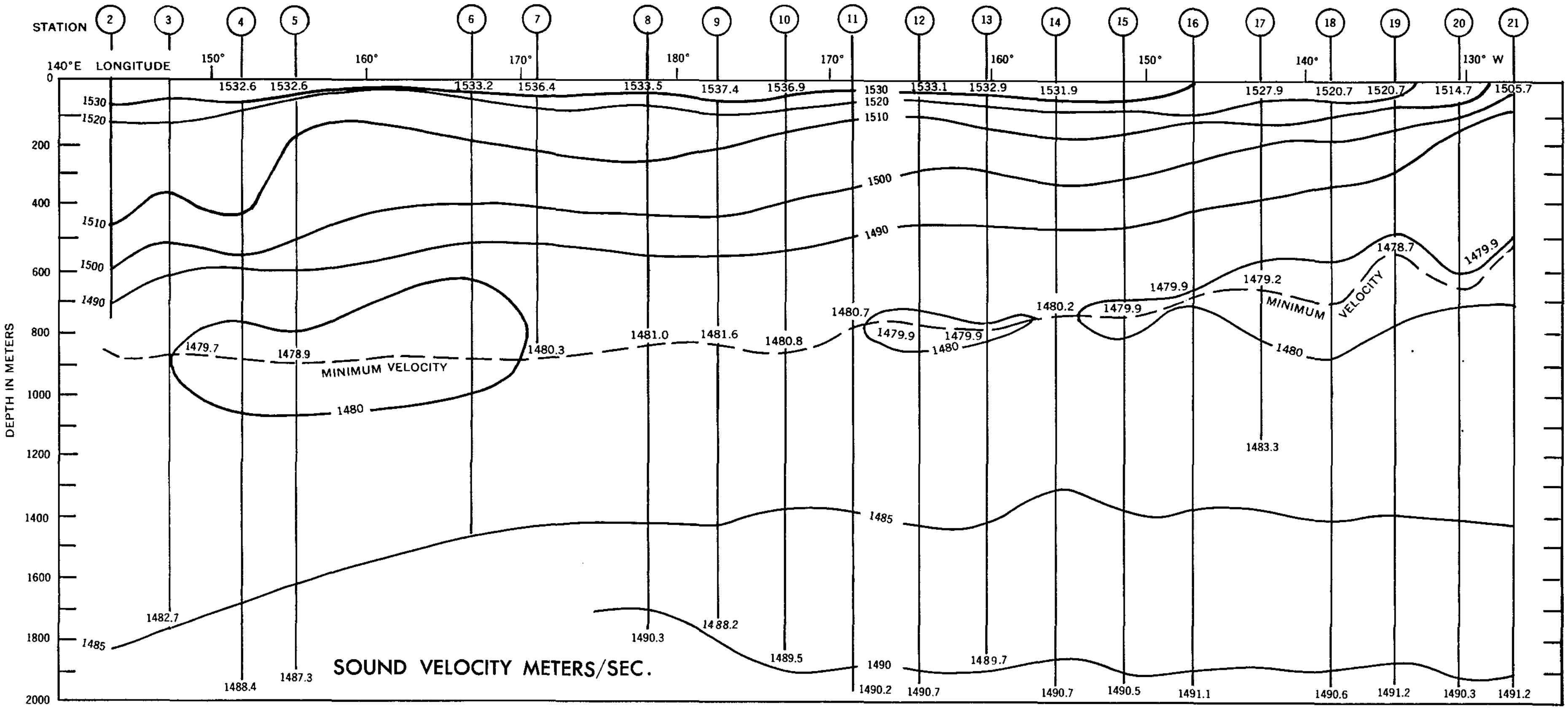

FIGURE 5. SOUND VELOCITY SECTION ACROSS PACIFIC OCEAN OCTOBER 1969.

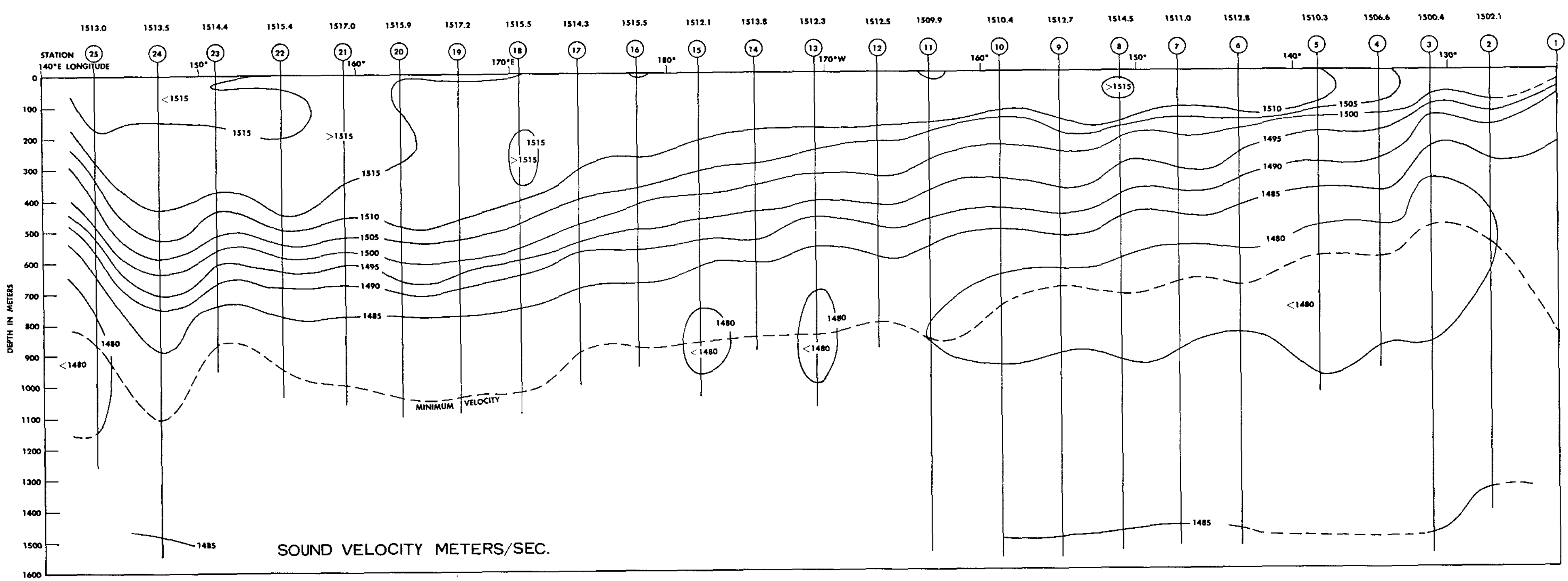

FIGURE 6. SOUND VELOCITY SECTION ACROSS PACIFIC MARCH 1968

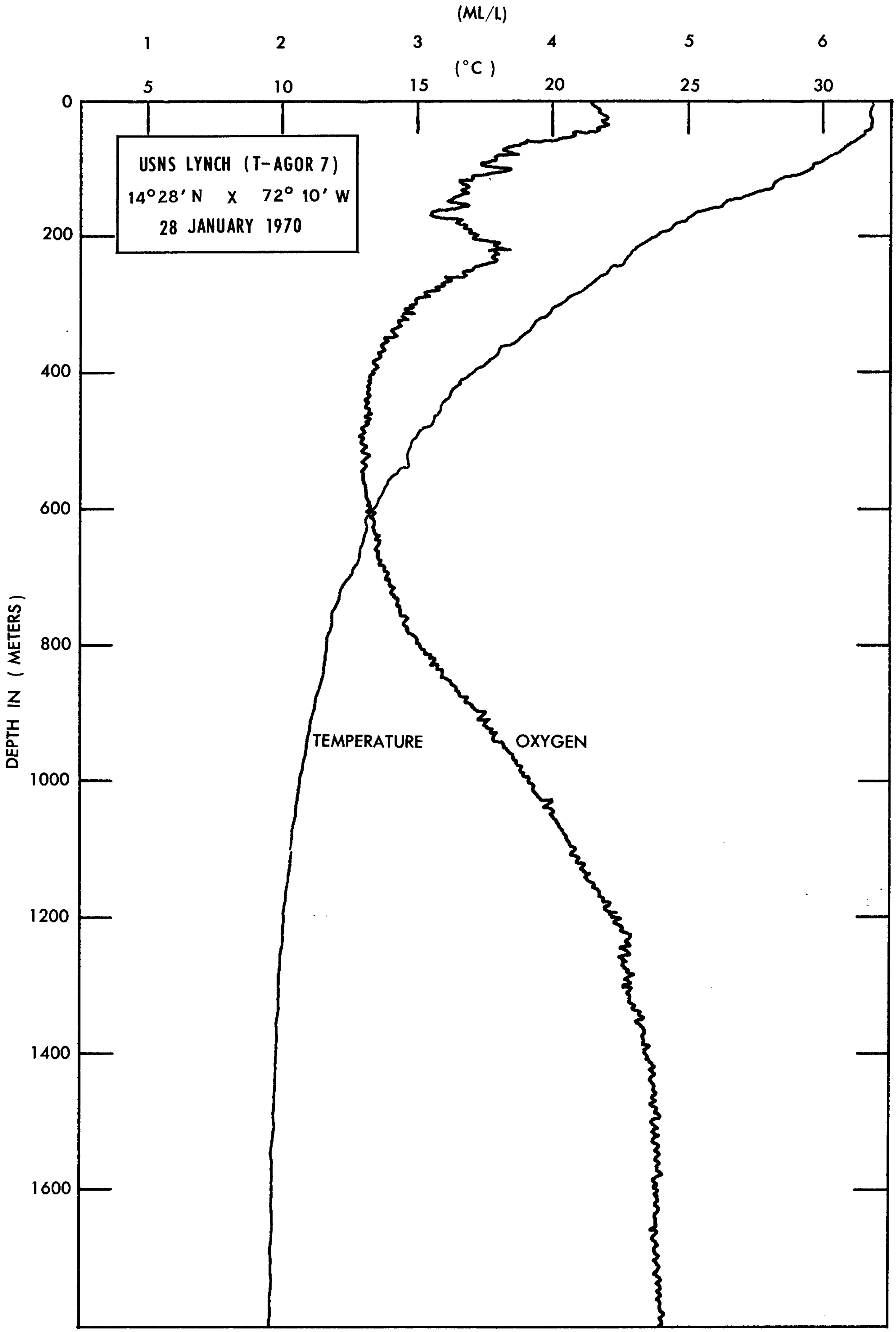

FIGURE 9. SIMULTANEOUS PROFILES OF TEMPERATURE AND DISSOLVED OXYGEN.

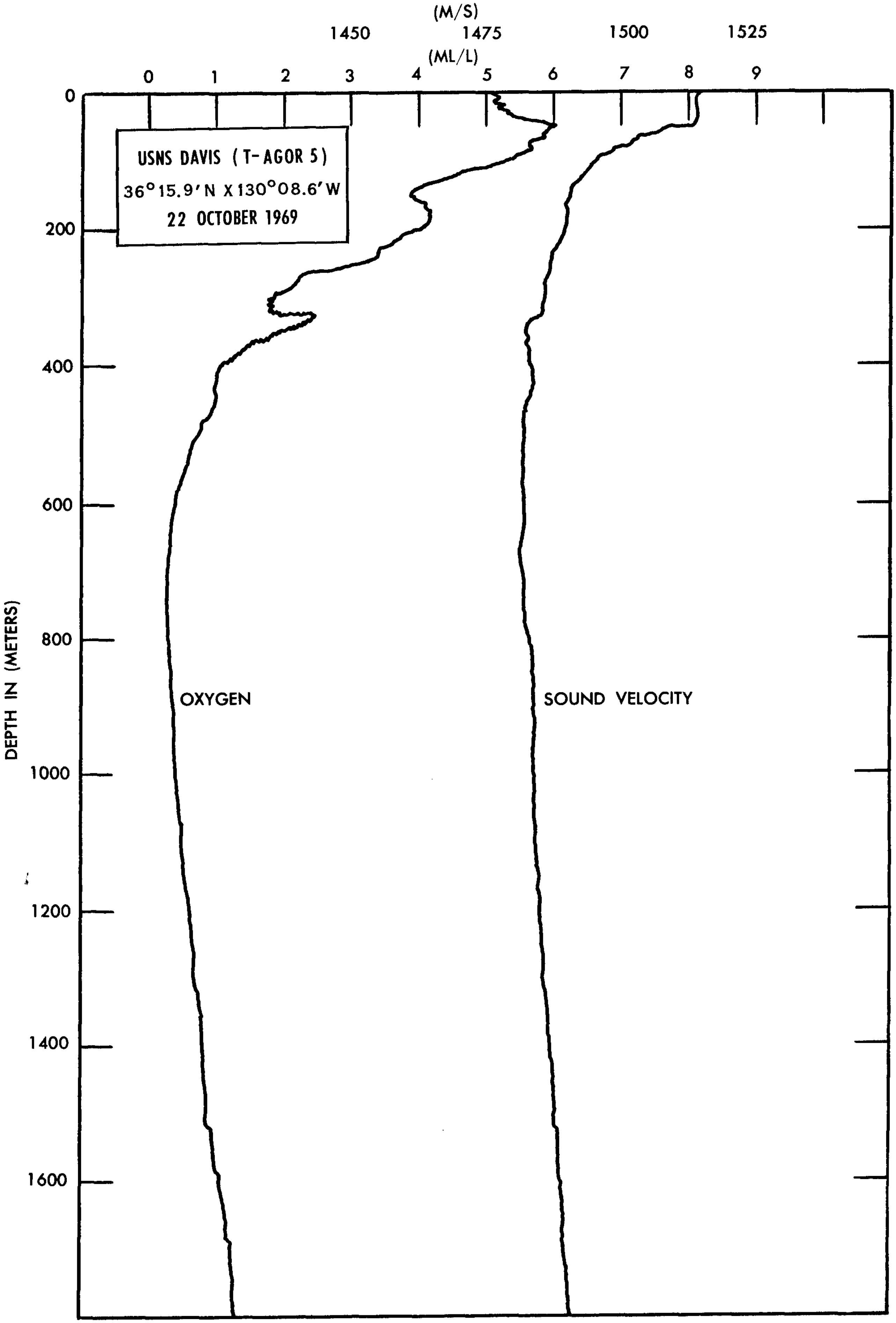

FIGURE 10. SIMULTANEOUS PROFILES OF SOUND VELOCITY AND DISSOLVED OXYGEN.

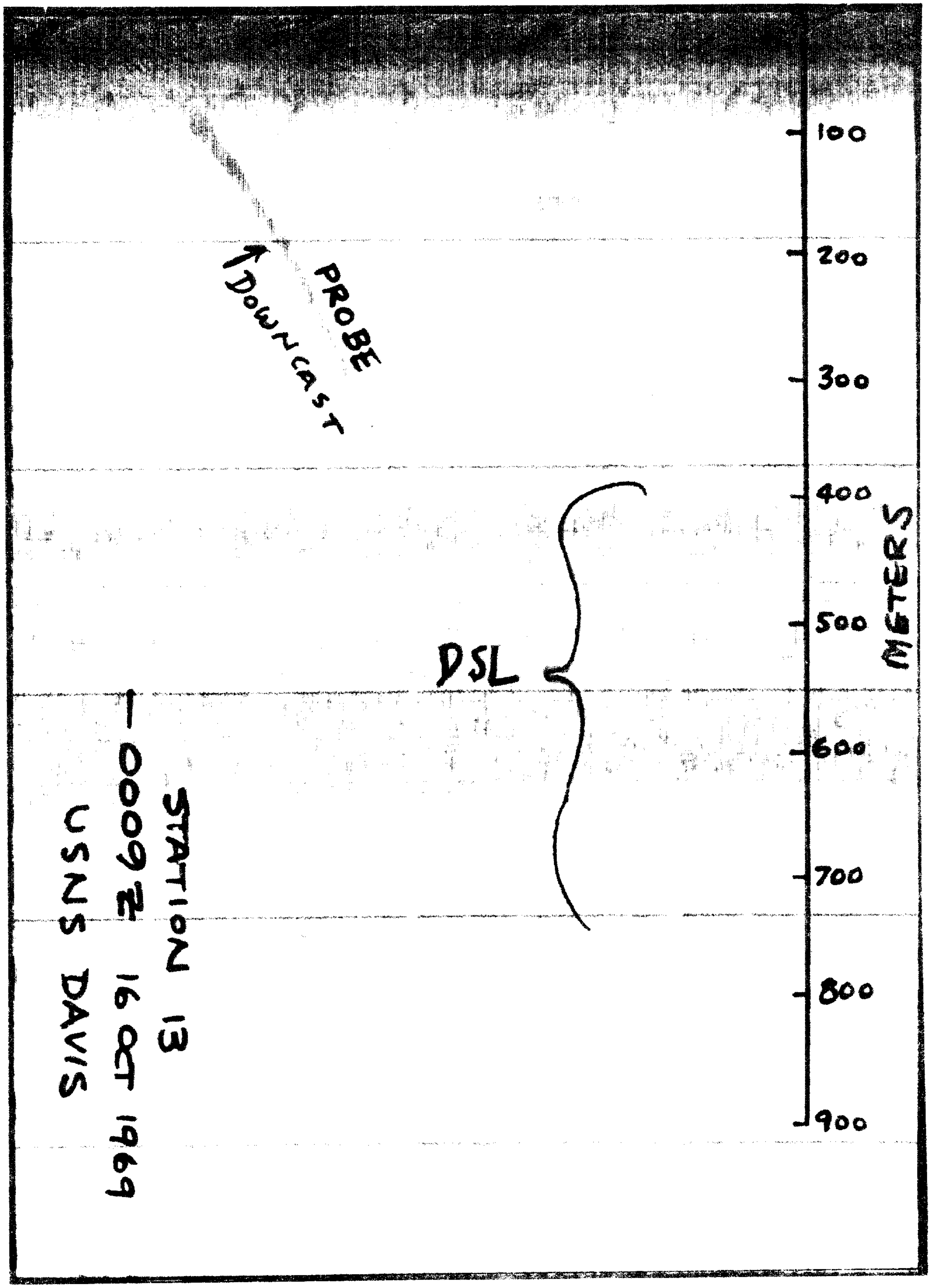

FIGURE 11. ECHOGRAM SHOWING PROBE DESCENDING THROUGH DEEP SCATTERING LAYER.

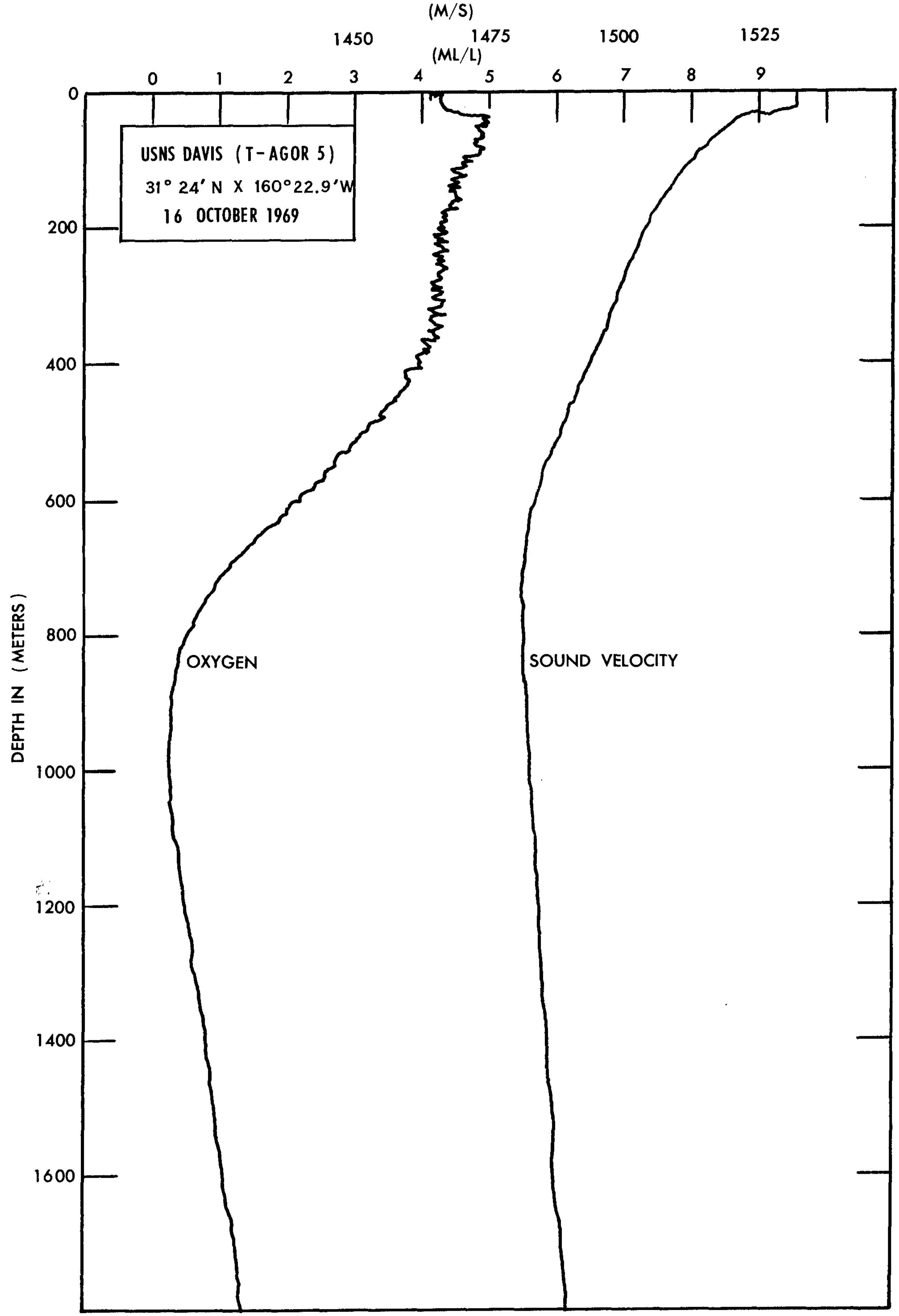

FIGURE 12. DISSOLVED OXYGEN PROFILE THROUGH DEEP SCATTERING LAYER SHOWN ON FIGURE 11.

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